SOIL CATEGORIZATION FOR PRODUCTIVITY MAPPING BY USING REMOTE SENSING AND GIS TECHNOLOGY

Dr. Jatisankar Bandyopadhyay, Assistant Professor*

Kartic Bera, Senior Research Scholar*

Arpita Patra, Student*

ABSTRACT:

Soil productivity can be defined as the ability of the soil to produce crop under a physically defined set of management practices. To assess the productivity of soil physical & chemical properties of soil, drainage density and climatic condition are considered. The present study has utilized the analytical capabilities of Geoinformatics in generation of thematic information on productivity of Jamboni block.

The physical land qualities indicate that the study area has a potential for agriculture crops. The criteria considered for land suitability classification are Soil properties, Drainage, Land use/Land cover, Relief, Slope. The crops that are selected for evaluation of physical characteristic are Rice, Sorghum, Sunflower, Cotton, Soybean and Arhar.

Key words: Soil productivity, cropping pattern, Crop suitability zone.

INTRODUCTION:

Soil resources are very much essential for India, where agriculture is the mainstay of our national economy. In the coming decades; the world community will face an enormous challenge concerning food security, food supplies and sustainability in agricultural development environmental conservation, and preservation, (Rashed et al. 2009). But the population growing pressures with an increasing variety of demand being made on land resources have create

* Department of Remote Sensing & GIS, Vidyasagar University, Paschim Medinipur, Midnapore-721102, West Bengal, India

enormous pressure on the available resources of the country. Such issues as food security can only be addressed through the capability to define changes in agricultural production. Agricultural land is a fixed quantity and that not all land is equal in its productive capacity, the ability to relate land use changes to the soil on which they occur is an important capability.

A method for defining the impact of land use conversion is available by combining remotely sensed land use information with ancillary soil data (Egide L. Nizeyimana et al. 2001). In this study productivity of soil has been carried out with the help of some physical and chemical properties of soil. And the soil quality and potential soil productivity also try to carry out conservation practices are essential step in the process of alternative agricultural productivity.

GENERAL ASPECT OF STUDY AREALOCATION MAP

Location: The study area (Jamboni block) is located in Paschim Medinipur district of West Bengal, India. It is bounded on north side Binpur block-I on the southern part by Gopibaiiavpur-II; on east by Jhargram block; on west by Jharkhand district.

Latitude & Longitude: 22^0 35′5″ N to $22^0$17′46″ N and 86^0 48′ 02″E to 86^0 45′46″E.

Toposheet no: 73J/14 & 73J/15.

Scale- 1:50,000, Jamboni block Includes10 Gram Panchaite and 343 are villages (Fig.1).

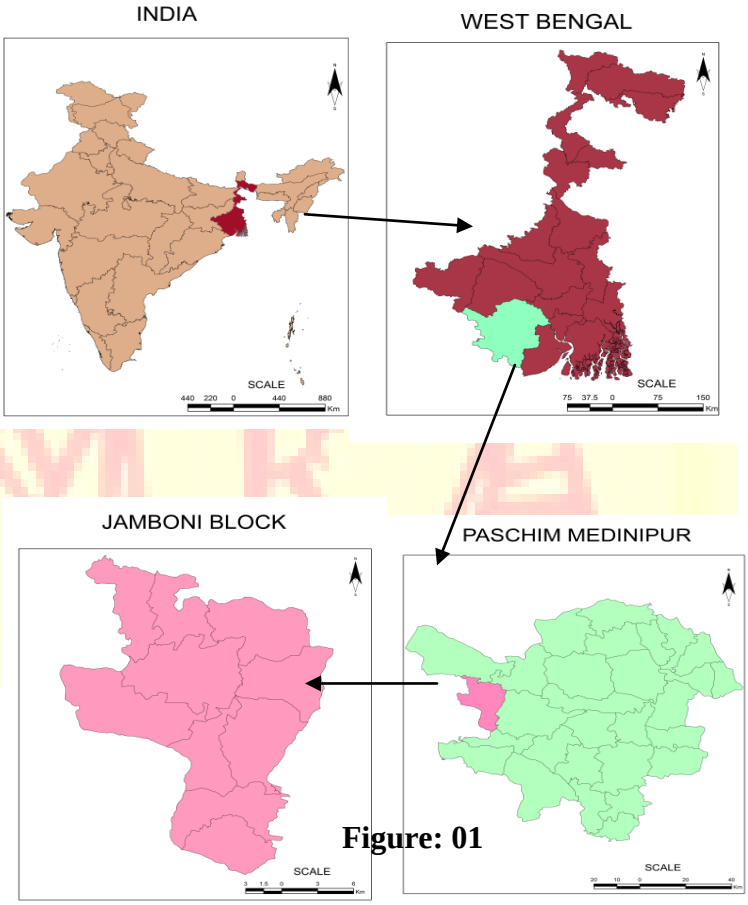

Figure: 01

ABOUT STUDY AREA:

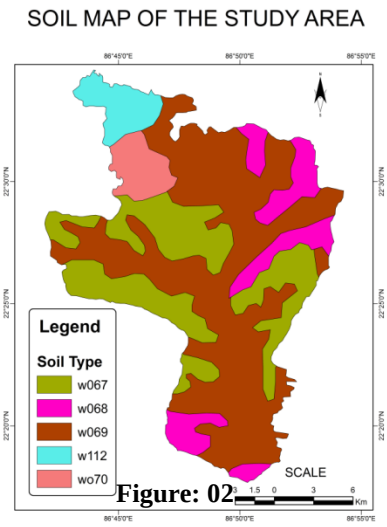

Figure: 02

1. **RELIEF:** The general elevation of the study area ranges from 50 to 150 m above the mean sea level. The north part elevation is 50 to 100 m. And others part elevation is 100 to 150 m.

2 SOIL: The soil of the study area (Fig: 02) is mainly divisible in two groups 1.Undulating plain interspersed with mounds & vally (Red and lateritic and alluvial soil) are classes a) coarse loamy, Typic Haplustalfs (W067). b) Fine loamy, Ultic Paleustalfs (W068). c) Fine loamy, Aeric Ochraqualfs, Fine Aquic Haplustalfs (W069). d) Fine Aeric Ochraqualfs, Fine Typic Ochraqualfs (W070). 2. Dharwar landscape (Lateritic soil) are class a) Fine loamy, Typic Haplustalfs (W112).

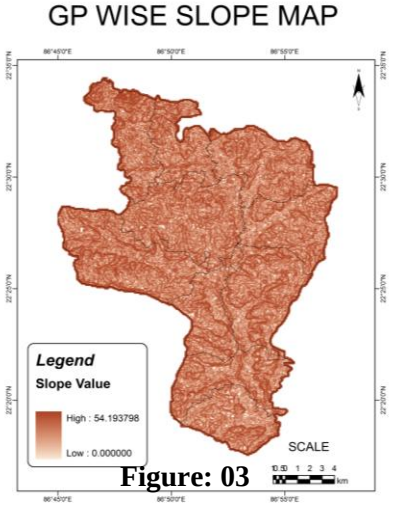

Figure: 03

3. **SLOPE:** The study area land slope is generally 10m/ km. Slope of a given area (Fig.3) plays an important role for agricultural activities in general and specially in case of crop production. Slope defines if an area is workable at all or not, its erosion hazard too. Thus the study of slope is an important factor for the land suitability study for agricultural crops. The slope of the study area was derived from the DEM which was obtained from the SRTM data.

4. **GEOMORPHOLOGY:** Geomorphology of the study area (Jamboni Block) can be divided into three major units, i.hard rock terrain with extremely rugged topography in the north western part of the block, occasionally covered by lateritic. ii. Lateritic covered platform sedimentary areas under lain by deposits of older alluvium bearing rolling plains in the north-east part and some south part of the block iii. Conglomerate rock is covered in the south- west part of the study area.

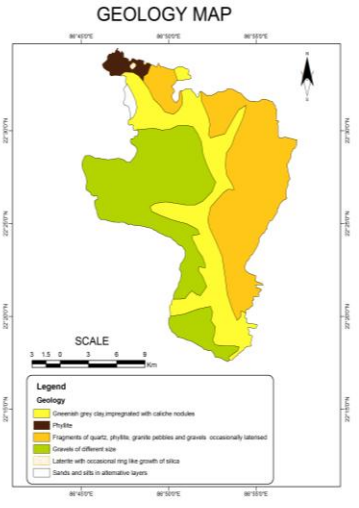

Figure: 04

5. **GEOLOGY:** This block is underlain by different geological formation ranging hard consolidated rocks and unconsolidated alluvium of resent age (Fig.4). a) The hard consolidated rocks are

pyrite, mica schist, Quartz hornblende schist, dolorite, etc. The phyllite rocks are hi highly deformed with foliation treading. Weathering of these rocks along the structurally weak plans caused formation of lose megalithic material. b) The lateritic upland areas are underlain by a thick sequence of clay slit sand of various grades and gravel down to the depth of 300m C) The quaternary formation comprises newer alluvium of recent age and older alluvium of Pleistocene age. The older alluvium is restricted to the fringe area of the platform terrain.

6. **CLIMATE:** The study area is subtropical and sub humid, with hot wet summers and dry winter. It is an annual average rainfall is1502mm, annual mean temperature of 26.25^{o}c. The Jamboni block experiences inadequate and irregular rain fall and suffers from tremendous water storage specifically during summer months. The mean maximum temperature during summer is 36.0^{O}C, monsoon is 31.5^{O}C and winter is 25.5^{O}. And the mean minimum summer temperature is29.0^{O}, monsoon is 26.0^{O} and the winter is 14.5^{O}C.

Rainfall and water availability are more serious climatic factors constraining agriculture in the study area. This rainfall seasonality is influenced by the southwest monsoon. About 70% of the annual rainfall occurs within the monsoon period, which lasts roughly from June to September. Average annual rainfall varies between 1346.0mm (2000) and 811.2mm (2011). The monsoon rains can be very intensive and erosive.

7. **DRAINAGE:** The major river Subarnarekha tributaries are Tarapani and Dulung is covered along the study area. The Dulung river flows mainly NW to SE traverses through Jamboni block and ultimately it meets the Subarnarekha River in Rohini Block. The area is also fed by drainage system of Palpala: Dev nala; kupan nala etc. Drainage is the most important factor impacts the Aus paddy; Aman paddy; Baro paddy and the other crops cultivation.

IRRIGATION**:** This block located along the Dulung nala, tarapani, palpala, devnala, Kupan River at middle part of block. The irrigation is also supply dulung nala, Kupan River, other cannel. So the main irrigation scheme which provides water for the agricultural fields for kharif crops. Surface water is being used for irrigation for Robi and summer crops.

8. **GROUND WATER LEVEL:** The ground water is most important factor of the Robbi crops. The ground water is different layer of the study area, like 75 to 125ft. Irrigation is depending on the ground water level. The ground water table is high in the South Western part where as moderate in the middle part and low in the North West part.

9. **AGRICULTURE**: Cultivation of the area is predominantly mono-cropped. Paddy is the primary crop of the district. The crops are grown mostly under rainfed condition; generally with low fertilizer consumption per unit area thus per hectare production is also low. The fertility of the soil helps different types of crops to grow in Jamboni block. The area under different cccrops like Aman paddy, Aus paddy, Boro paddy, maize, potato,ground nut, sesamum, wheat etc.

10. **SETTLEMENT:** The study area - 318.30/sqKm; Total Population-101718; Male Population-51880; Female Population-49838. Total literate Population -58232 and Total illiterate population- 43486.Total worker population 48096. Total cultivator population 7165. Population density is 320/Km^2 (Fig.05).

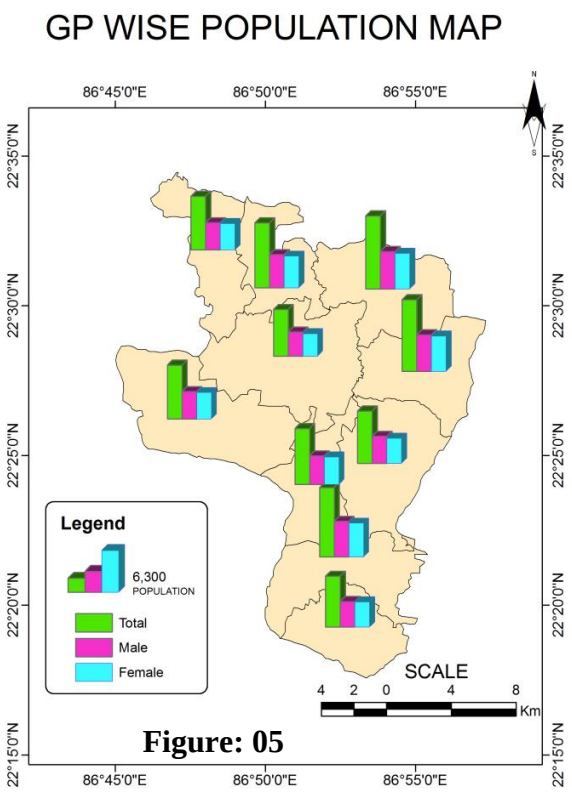

Figure: 05

AIM OF THE STUDY: Productivity mapping based on soil categorization

OBJECTIVE OF STUDY:

- Preparation of exiting land use/ land cover map
- Soil physical & chemical properties
- Reclassification.
- Soil productivity mapping.
- Analysis of seasonal cropping pattern.
- Crop productivity map
- Crop suitability zone

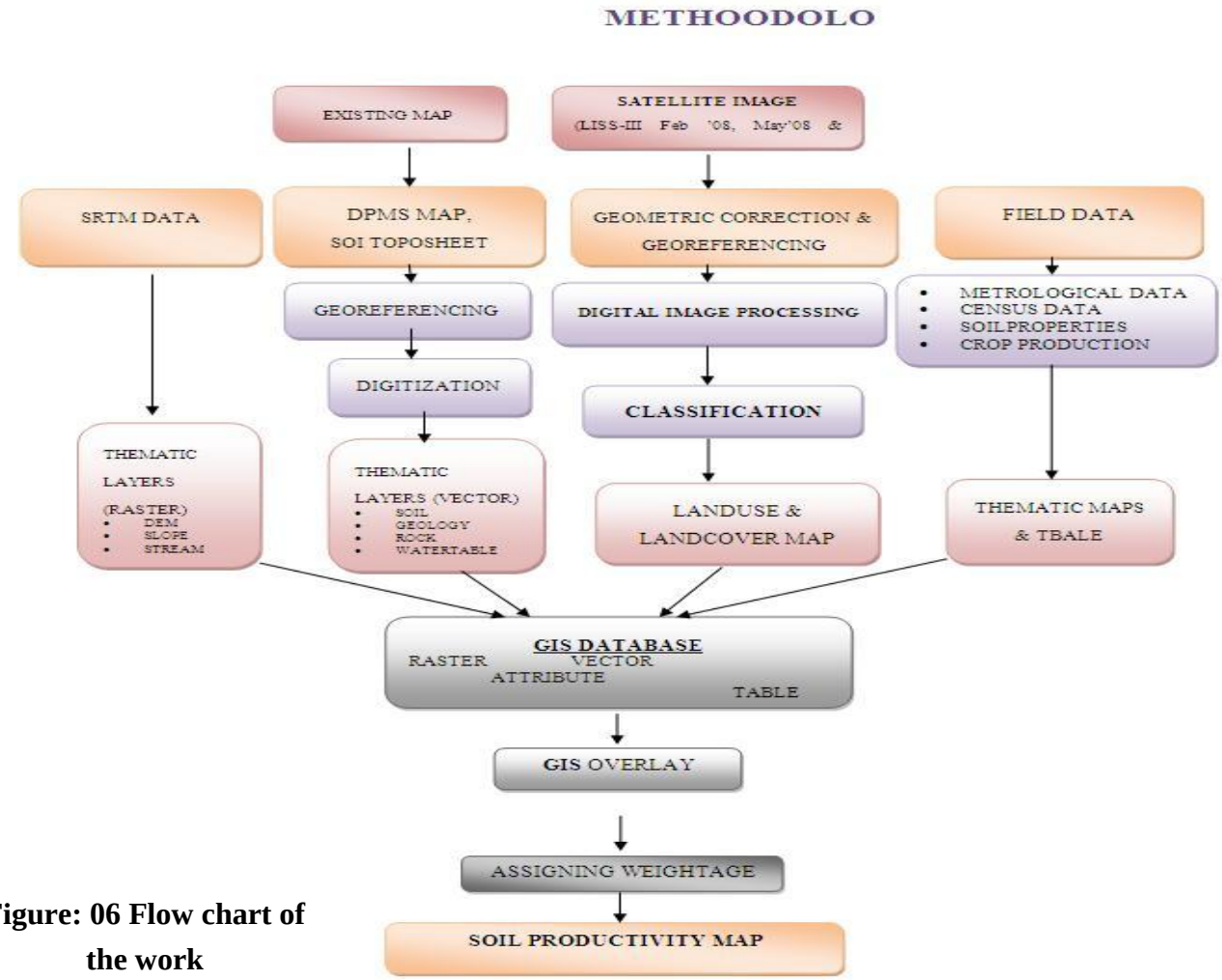

Figure: 06 Flow chart of the work

Result and Discussion

1. SOIL: Soil is an important determining factor for land suitability evaluation of agricultural crops. For the study, the soil mapping unit of this area is used for analysis. The physical and chemical properties of the soil mapping units are used for interpretation and analysis. GIS provides an advantage of mapping these properties of soils separately and make them ready for further overlay analysis to identify which unit is best or worst for the selected land utilization types crops. Soil category class

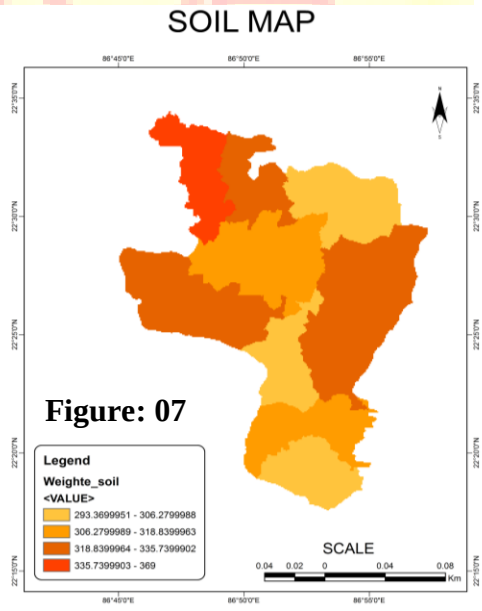

Figure: 07

weights are PH - 8; N_2 - 7; P_2O - 6; K_2O - 5; and Oc - 4 (Fig.07).

2. **LAND USE & LAND COVER**: The land use/ land cover of the study area has been obtained by performing a supervised classification on the satellite imagery based with field work data. Accordingly training points identified to represent the various land use classes were marked using GPS during the field visits. These GCP points were used to sample representative signatures for different landuse classes. The categories included Upper terrace, Single Crop area, Double Crop area, Forest, Degraded Forest, Water bodies, Sandy Area and Settlements. These landuse/ land cover were re-classified to make it compatible with other parameters used for the analysis. The asine weightages of Land use & Land cover Category class weight are River-6; Seosional Crops -5; one crop-4; Open forest-3; Dry Fallow- 2; and Deep forest, Sand, Settlement-1 (Fig. 08).

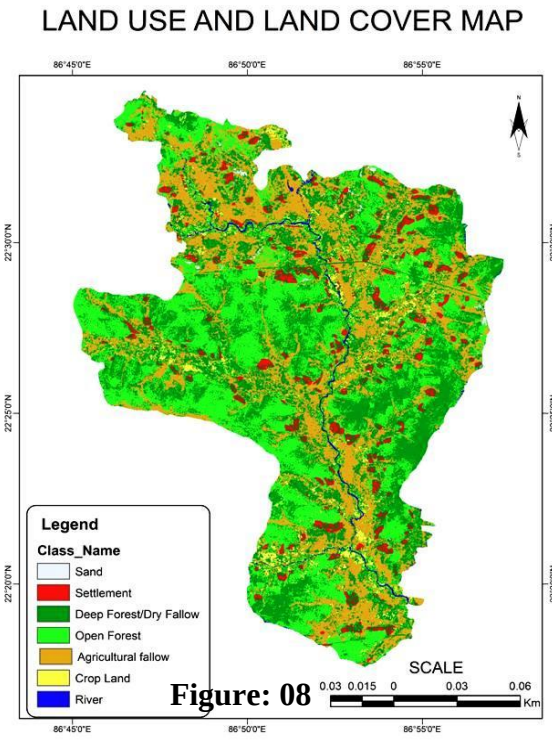

Figure: 08

3. RELIEF: Relief is an important determining factor for land suitability evaluation of agricultural crops. For the study, the Relief mapping unit of this area is used for Reclassify soil mapping. The Relief category is High, Medium and Low. The High class weightage are 2; Medium class weightage are 5 and Low class weightage are 7 respectively (Fig. 09).

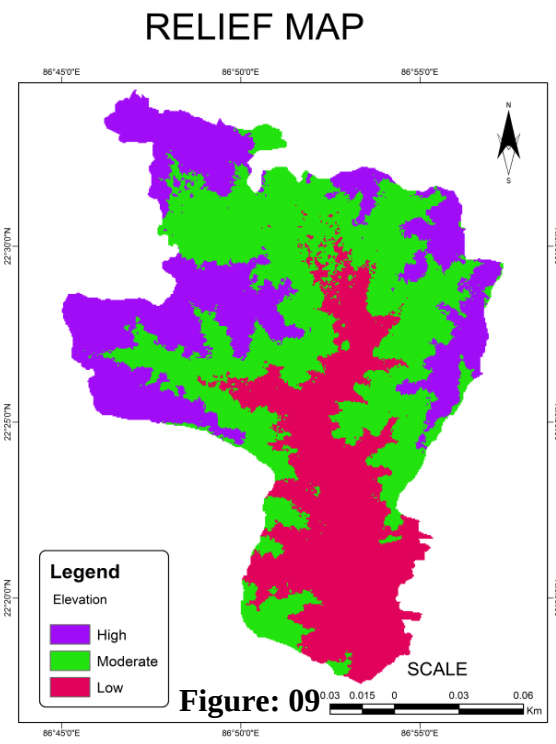

Figure: 09

4. DRAINAGE DENSITY: Soil drainage condition is important as it controls the soil-cum-water relationship and the supply of nutrients to plants. Deep well drained soil shows a root penetration until below 150 cm for most crops. The drainage density is high, middle of the study area. Where Drainage Density is high, there is most suitable soil for the agricultural crops (class weight-5). Moderate drainage density class weights are 4 and low Drainage density class weight-2 (Fig.10).

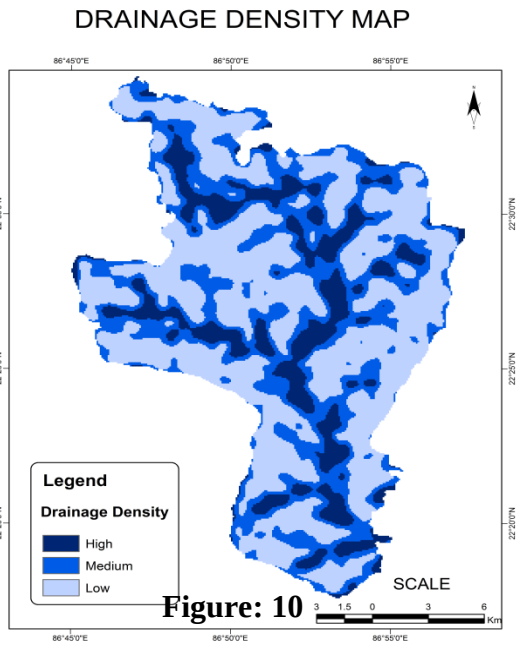

Figure: 10

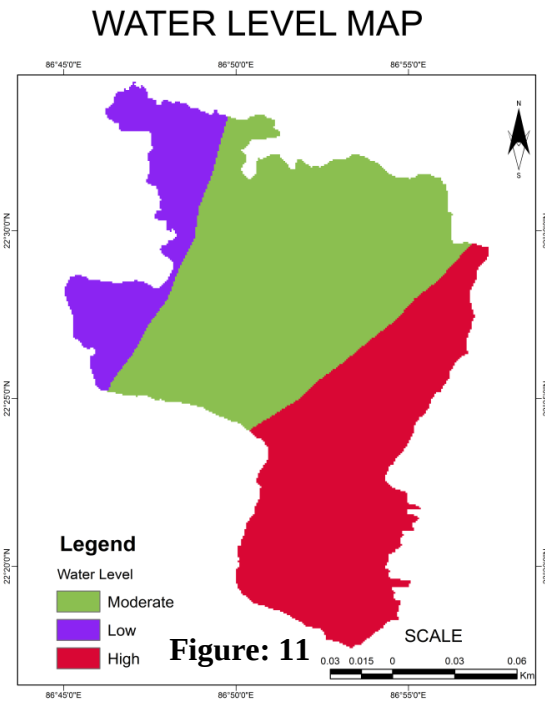

Figure: 11

5. GROUND WATER TABLE: Ground water table is most important factor or soil suitability for agricultural crops. Mainly Rabi and Summer crops are depend on the ground water through deep tubules; mini; submersibles etc. so the high ground water table is best for the agricultural crops (Fig:11). The study area ground water table is high in South Western part (class weight-5). Whereas moderate in the middle part (class weight-3) and low in the North West part (class weight-1).

6. GEOLOGY: Geology is the important factor for the land suitability of crop production. The geology categories of Greenish Grey Clay are best for the agricultural crop production. And other category - Phyllite; Fragments of Quartz, Phyllite, Granite Peables and Gravels; Gravels; Laterite; Sand with Slit etc. class weight is 1 (Fig: 12).

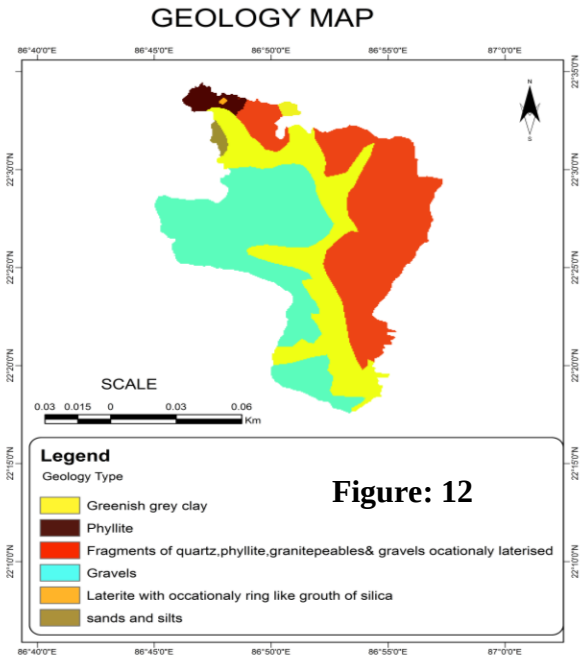

Figure: 12

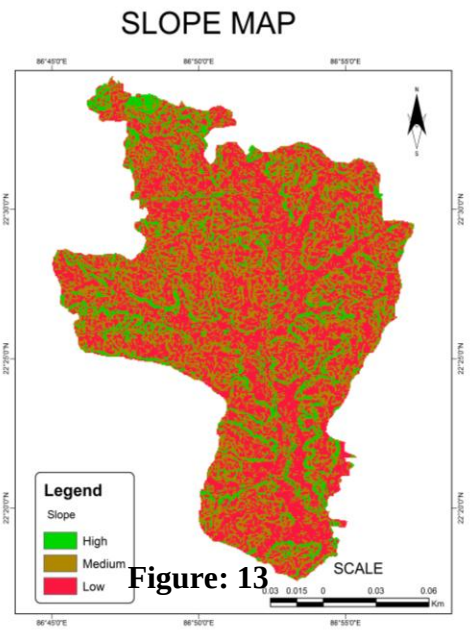

Figure: 13

7. Slope: Slope of a given area plays an important role for agricultural activities in general and specially in case of crop production. Slope defines if an area is workable at all or not, its erosion hazard too. Thus the study of slope is an important factor for the land suitability study for agricultural crops. The slope of the study area was derived from the DEM which was obtained from the SRTM data. Low slope area is better than the high slope area for agricultural activity in general and specially in case of crops production. The Slope category class weights are high-1, medium-2, and low-3 (Fig: 13).

SUITABILITY MAPPING: Different parameter of Soil properties- PH, N_2, P_2O_5, K_2O, Oc, Landuse/ Land cover, Relief, Drainage density, Geology and Slope are the most impotent category of soil productivity and crop suitability zone mapping. This categorys sum weightage overlay creates the suitable cropping zone. This map is representing the six classes (1 to 6) of crop suitability zone. Among the classes 3 and 4 are high productivity for agricultural crop; 1 and 2 classes are the moderate and 3-4 are the low Suitability zone (Fig: 14).

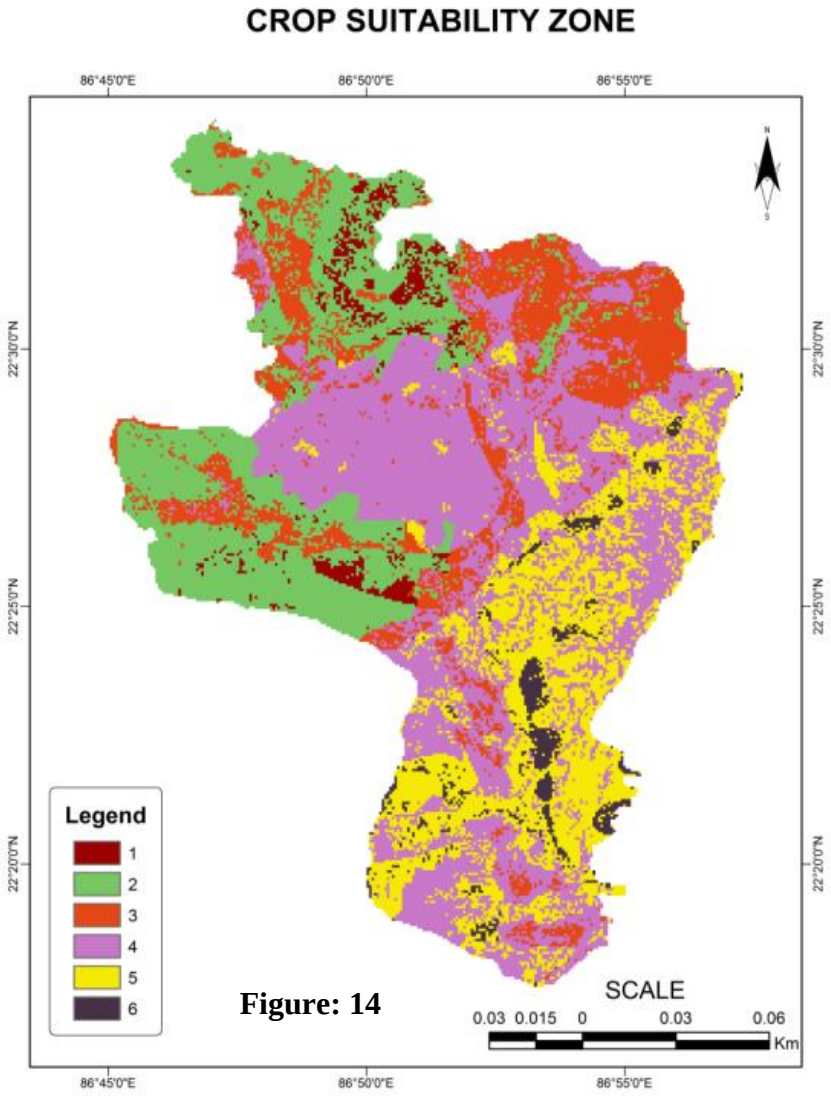

Figure: 14

Crop Production: Crop production is mostly depending on Rainfall and Irrigation system. This study area is mainly 6 types of crops like Amon paddy; Aus paddy; Bara paddy; Wheet; Mustard and Potato etc.Amon Paddy is important crop in this Block. The amount of crop production is high 2008-2009 and low production is 2010-2011 year. Because the lack of sufficient rainfall in this year (2010-2011) table no: 01 and Fig: 15. Based on the crop suitability zone, estimate crops production per hector wise in table no: 02.

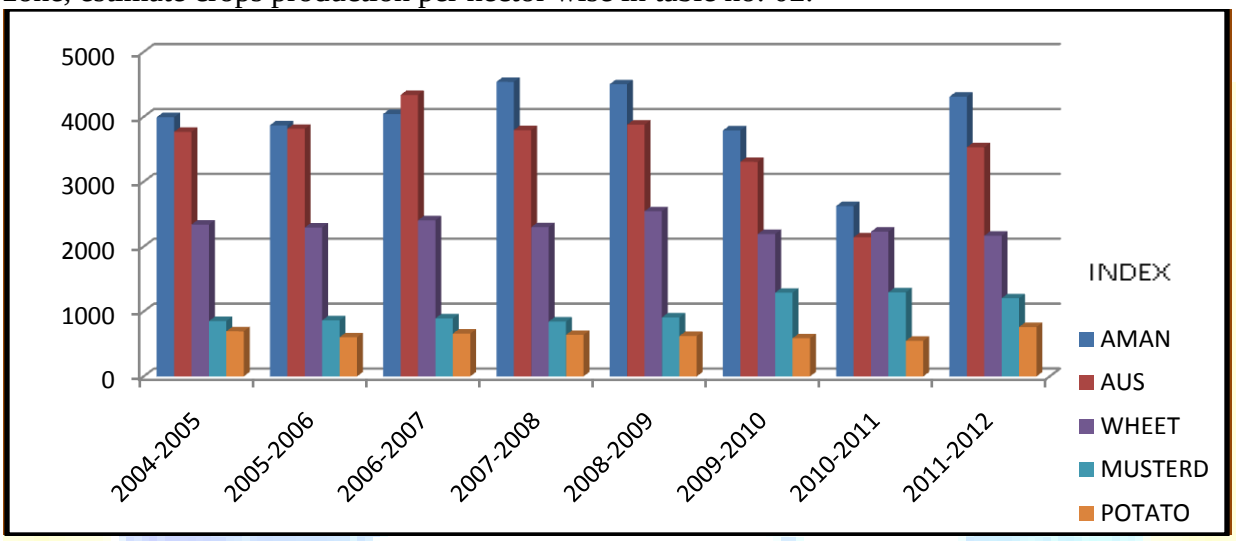

Figure: 15, Bar-diagram represent the year wise crop production

CROPS	Table no: 01, Amount of Crop production/hector (Year wise)							
	2004-2005	2005-2006	2006-2007	2007-2008	2008-2009	2009-2010	2010-2011	2011-2012
AMAN	3994	3870	4044	4539	4502	3790	2625	4310
AUS	3769	3815	4338	3795	3879	3306	2144	3530
BORO	3738	3760	4556	4225	4608	4404	4423	4230
WHEET	2340	2294	2405	2300	2545	2194	2230	2168
MUSTARD	852	863	894	845	908	1290	1295	1204
POTATO	695	603	659	640	622	588	548	761
Source- ADO Office, Jamboi block								

Table no:02, PROPOSED ALTERNATIVE CROPS			
Sl No.	**Crop**	**Yield/hacter**	**Market price Rs. / (q)**
1	Rice	2.4-2.8 Ton/ha	900
2	Sorghum	2.5-3 Ton/ha(Seed)	1600
		5-6.5 Ton/ha(straw)	1110
3	Sunflower	0.5-0.75 ton/ha	2400
4	Cotton	6-8q lint(fibre)/ha	2600
5	Soybean	2-2.7 ton/ha	5000
6	Arhar	8-11 q/ha	3400

CONCLUSION

This dissertation paper confirmed the method used is adequate to integrate Soil, Drainage density, Relief, ground water table, geology, Slope in a GIS context. The weighting factor process generated is demonstrated to be useful to delineate important information, which could be useful for productivity mapping. The overlay method applied here could be useful for the specialist's productivity mapping and reliable approach to demarcate suitable areas for crops through a GIS context. This technique has been applied for a multiple alternative crops in this study. It has potentiality to be applied for a multiple of crops at the same time. This approach can be further enriched by incorporating other socio-economic and environmental variables to obtain the optimum results.

The study shows the standardized criteria maps for Rise, sorghum (seed, straw), Sunflower, cotton, soybean and Arhar etc. (Table.2). Each of the criteria has been separately analyzed for their suitability supporting alternative crops.

REFFERENCE

- Dr. Harold Reetz, Soil sampling for yield agriculture, pp. 6-13.
- John O. Agbenin1 and Peter Felix-Henningsent (1999), Management strategies for sustainable soil productivity,pp. 2-3.
- J. Punithavathi*, S. Tamilenthi and R. Baskaran (2011), Interpretation of soil resources using and GIS, pp. 528-535.
- Jane Schubert and Pak Chagarlamudi Jack A. Shields & Alex R. Mack (1980), Stratification of land sat data by uniformity productivity of soil
- Petersen Gary w. Assessing soil productivity losses due to urbanization
- Rajith Mukundan , Application of soil productivity assessment and mapping
- S.Rasheed.K. Venugopal (2009) Land suitability assessment for selected crops in vellore district based on Agro-ecological charecterisation, pp.616-628.
- Srikanth K.S. (2007), Estimation & monitoring of soil moistutre and identification of soil pructivity.
- S. K. Bhan, S.K. Saha, L.M. Pande and J. Prasad Sustainable agricultural management and development**.**
- V.Madhava Rao a*, Agro-climatic planning and information bank (APIB), pp.1451-1455.
- V.K. Dadhwal , Cop growth and productivity monitoring.